

Monetizing movement analytics: new revenue opportunities for mobile operators

The purpose of this White Paper is to identify for mobile operators the significant opportunities in movement analytics available through the intelligent use of mobile network assets. Leveraging unique data assets from networks and mobile handsets, mobile operators are able to design and develop new services based around movement analytics. This new service is achieved by processing a combination of data through advanced data analytics tools of INRIX. In so doing mobile operators will be able to create a wide range of applications for large enterprises, public sector organisations and business service providers.

1 Introduction

There are currently three major and interconnected revolutions taking shape in technology today: the widespread adoption of smartphones, the increasing pervasiveness of connected devices (in the form of the Internet of Things), and the greater adoption of sophisticated techniques for the analysis of aggregated data.

Smartphones currently account for over 60% of handsets in the developed world, a figure which is expected to rise to 70-80% within the next four years.¹ By 2020, the GSMA expects close to 5.9 billion smartphones across the developed and developing world.²

The growth of the Internet of Things is set to be a defining technology trend of this century. Machina Research forecasts that by the end of 2024 there will be more than 25.6 billion IoT devices active around the

world. Smart, connected devices generating real-time information exchanges, combined with advanced data analytics are set to transform the world in which we live.

Enterprises are leveraging this growth by designing and developing new and innovative products and services based on the combined analysis of real-time and historical data. This inclusion of IoT-generated data will change markets, processes, business models and ultimately customer experiences. Services in fields as diverse as retail, smart cities, healthcare and financial services are being adapted to take advantage of these innovative and disruptive technologies, transforming the companies in those sectors. Mobile operators will not be immune to these market transformations.

As the numbers of connected devices have grown, so has the capability to analyse the increasing amount of data coming from those devices. The

¹ GSMA, "The Mobile Economy 2015"

² GSMA, "The Mobile Economy 2015"

real value in movement analytics comes from this increasing amount of data *combined and processed* with other untapped data sources such as information about road layouts, major event schedules, and forecast weather conditions to mention a few.

These three ‘revolutions’ present three opportunity areas for mobile operators:

- Leveraging the unique data assets of mobile networks
- Tapping into the power of real-time data analytics
- Designing movement analytics services as a new tool

Leveraging the unique data assets of mobile networks

The mobile network generates significant amounts of data which, when analyzed and managed in detail, delivers new insights into population and/or movement analytics. This is implicitly of use to the likes of city planners, transport agencies, and enterprises, looking to tap into these new insights to gain competitive advantage. For mobile operators, it is an opportunity to monetize the data assets they already have.

Tapping into the power of real-time data analytics

For service providers such as INRIX, developing advanced tools to manage

and mine real-time and historical data for insights, has delivered significant opportunities to help customers develop and launch new services such as transportation management solutions and population analytics tools, a precursor to movement analytics. In many ways, it has helped enterprises monetize their early data assets.

Significant changes have taken place in data analytics in recent times. The growth in the number of connected devices and rise of the Internet of Things has dramatically affected the three ‘V’s (volume, velocity and variety³) of data.

The availability of more sensor data allows for massive expansion of the, more well-established, historical data analysis. Furthermore, increasingly data will be extracted and processed in near real-time. The format of the data is also changing; from a world where the only data processed was that of well-defined and structured data, new systems are having to cope with unstructured data in the form of, for example, audio and image files.

With significantly more data available, Big Data and advanced data analytics have enabled enterprises to make greater use of the data. Thoroughly understanding the context within which the data was generated, and ultimately combining different sets of data to provide richer

³ For more information about Big Data and the Five S’s (or three V’s as otherwise referred to), read Machina Research’s

White Paper on “Big Data in M2M: Tipping points and Subnets of Things,” published February 2013

information insights, Big Data and advanced analytics (with new algorithms) have opened new opportunities for descriptive, predictive and prescriptive analytics, increasing the overall power of data analytics.

Designing movement analytics services as a new tool

Movement analytics is changing industries and business processes. Combining and processing historical and real-time data from mobile networks and GPS information, mobile operators are capable of delivering completely new services to retailers, city planners, venue and event organizers and departments responsible for traffic and transport management, and ultimately the emergency services.

This new service, driven by real-time data allows clients to gain and develop insights about the flow and movement of people or things connected to the mobile network. With this information, they can develop and formulate appropriate actions to optimize movement, minimize disruptions, and ultimately create a safer and more secure environment for people. One has to look no further than the development of Smart Cities to identify how significant movement analytics as a service will become.

2 Identifying new sustainable revenues for mobile operators

Mobile operators are increasingly searching for new revenue opportunities to complement their traditional revenue streams and business models.

Opportunities in road traffic information have shown a highly successful path for the use of mobile network data.

With movement analytics, large scale opportunities in city planning and transport management have started to emerge. Another example of the value of movement analytics is seen in the growth of connected out-of-home (OOH) advertising. This has been significant with over 170,000 such OOH advertising sites in London alone, and here, movement analytics provides the estimated people traffic viewing these digital signs

Declining revenues from traditional services

Consolidating markets, increased competition, falling prices and rising costs have delivered significant challenges for mobile operators in developed markets. According to the GSM Association: "Revenue growth is forecast to slow further over the coming years, with a CAGR of 3.1% per annum through to 2020, down from just over 4% in the period 2008-

2014.”⁴ Although indicating some degree of stabilization, the trend reflects a mature and competitive market.

Mobile operators have to identify new revenue streams and Machine-to-Machine (M2M) communications and the nascent Internet of Things represents one such opportunity with new connected devices as diverse as connected cars, consumer electronics, healthcare equipment, industrial infrastructure, home security and smart meters. All are set for rapid growth in the coming years and all will require connectivity of some sort. Enabling innovations in the Internet of Things (IoT) will provide direct revenue streams; the provision of connectivity for new connected devices represents an opportunity of EUR8.6 billion worldwide by 2024.⁵ However, this is just scratching the surface of the new opportunity. The connectivity piece represents around 1.5% of the potential global addressable revenue opportunity for mobile operators from IoT. There remains substantial scope for mobile operators to extend their ambitions and pursue a greater share of IoT value added services.

One area of opportunity outside of mobile operators’ traditional focus revolves around the monetization of data. Mobile operators have always been party to vast amounts of data created by users. This data is not

extracted only for billing purposes. It also contains information about what is being communicated through the ‘pipe’ (content) and crucial data about its usage, its characteristics, quality and performance and additional information about the environment. In effect, mobile operators are information rich, and have started to explore the significant opportunities created by this data.

Using data to generate new services

Using data generated by mobile networks to build new services can take many forms. In recent years, mobile operators have explored the likes of payments, advertising, and location services. All share a common and untapped mobile network asset: data extracted from the mobile network.

However, using data from mobile networks to generate new revenue streams is not simple. It will require a new set of capabilities on the part of the mobile operators. They will need to understand the nature of the data generated, how it is managed within the network, and how and where it may be accessed (all points addressed later). It will also require mobile operators to implement new data management policies and guidelines as regards data privacy and data security.

⁴ GSMA, “The Mobile Economy, Europe 2015”

⁵ Machina Research Global IoT Forecast Database

The growing importance of data, and the sensitive management of that data, will require a high degree of trust of whichever organization is responsible for its handling. Mobile operators already occupy a position as trusted third parties and are certainly considered more trustworthy than over-the-top players. Recent data privacy challenges faced by Google in Europe have certainly made many individuals aware of the regulatory frameworks that mobile operators are subject to, and adding to their trustworthiness. As such they have a significant opportunity to interject themselves into this new data ecosystem, for instance by managing user portals for data permission management, implementing advanced data anonymization techniques, and supporting enhanced data storage and management technologies.

In traditional value added services, data from a subscriber's mobile device is used to drive the application. For mobile payments or location based services, the unique information from the individual mobile device is accessed through Application Programming Interfaces (APIs), requiring individual mobile subscribers to permit such usage. In these examples, specific data points are captured and used as identifiers. Increasingly, however, new services, underpinned by Big Data and advanced analytics, focus on

aggregated information from multiple users. Companies such as INRIX, are building platforms for mobile operators based on completely different and highly innovative approaches. These approaches include bringing significant amounts of network data together and turning it into valuable and significant information for applications such as movement analytics.

Identifying new innovative services

Before exploring movement analytics in further detail, let's examine why this application becomes even more important in the future, particularly as a revenue opportunity for mobile operators in e.g. Smart Cities.

Urban populations are growing rapidly. In 2014 54% of the world's population lives in cities, up from 30% in 1950, while the number of megacities, i.e. those with over ten million inhabitants, grew from 10 in 1990 to 28 in 2014⁶.

“Globally, more people live in urban areas than in rural areas, with 54 per cent of the world's population residing in urban areas in 2014. In 1950, 30 per cent of the world's population was urban, and by 2050, 66 per cent of the world's population is projected to be urban.”

United Nations Department of Economic and Social Affairs “World Urbanization Prospects: The 2014 Revision”

⁶ Source: UN World Urbanization Prospects report, 2014

Identifying and planning for the movement of people can have a range of economic, environmental and health benefits. Whether it is for their daily commutes, planning of additional transport systems or new road infrastructures, or identifying optimal locations for retail outlets, understanding how people and things move from point A to point B becomes a vital piece of information. Getting future transportation networks right will be crucial.

Working with historical and real-time data, improved transportation management solutions have certainly proved this point. (Traffic) data is gathered from a multitude of connected devices (vehicles) and information sources, and provides, through a process of data transformation, invaluable information to vehicle owners about traffic delays, weather conditions and alternative routes. As expressed, this has made the Estimated Time of Arrival (ETA) more of an 'accurate time of arrival.'

Movement analytics is the next and logical step from transportation management but the opportunities do not stop here.

For retailers, access to information from movement analytics provides invaluable insights for future site selection of retail outlets, for insights around customer behavior and competition analysis, and for identifying new insights and perspectives around store

performance. Movement analytics will deliver direct insight of historical and real-time behavior of groups of people, allowing retailers to optimize advertising and marketing initiatives, and deliver compelling benefits to customers.

There are certainly challenges when moving into this more complex data environment, as this paper will discuss in the next section. So what is movement analytics, and how could this become a new service with sustainable revenues for mobile operators?

Movement analytics as a new service

Movement analytics refers to insights gained from detailed knowledge about the trips and movement habits of groups of people. The topic itself is far from new. Data has previously been captured by individuals standing with clipboards and asking these questions of travelers, or in many cases, monitoring traffic flows at a given position without truly understanding the route taken.

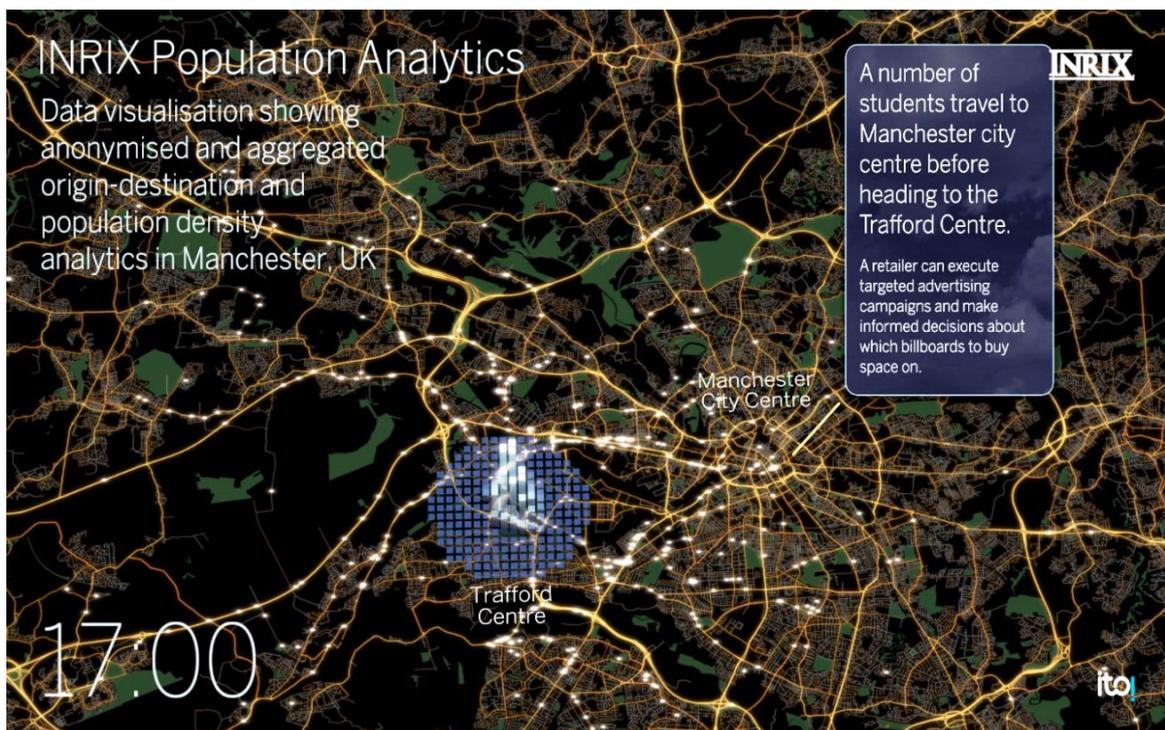
With the emergence of connected things and people, data about origins and routes have become more readily available, and provide a quicker, more efficient and more timely source of data. As more things become connected, the volume of this data will start to deliver more and more detailed insights about movements of 'populations.' In this new age of the Internet of Things,

data about movement will become pervasive, and having the right tools to store, transform, and mine this data will be invaluable for new service propositions.

Of course, it is one thing to track the single movement of a device or a person from a point of origin to a destination. In most cases, this attempt would fail data privacy and data ownership criteria however much that piece of data was anonymized. When aggregated with say millions of other cellular data points in a single day, the value of the insight emerges at a completely different level – flows of movement emerge, and new visualization technologies certainly illustrate this.

In Figure 1, the visualization from ITO World, based on INRIX data, illustrates how movements of students to the Trafford Centre in Manchester, to attend one of the largest shopping events in the UK, affects local transport networks. The value of this tool, across real-time, is to show how movement takes place and where potential high footfall or congestion areas appear.

Figure 1: Visualisation of movement analytics: Students travelling to the Trafford Centre in Manchester [Source: INRIX/ITO World, 2016]



Movement analytics opens huge benefits for many enterprises and public agencies. These include:

- **Smart City Planning:** improving the flow of traffic, transport, cyclists and people around the city. Designing Smart Cities with the technology to manage and monitor these flows and in the cases of light rail and trams to monitor and address occupancy levels so as to improve customer experience.
- **Retail Locations:** identifying optimal retail travel footprints with information about origin and continued journeys, and which locations provide ideal retailing footprints.
- **Safety Planning:** identifying safer and alternative transportation routes to e.g. schools and for cyclists.
- **Pollution Monitoring:** monitoring the development of traffic, information about air pollution and alternative routes could be designed
- **Venue Management:** real-time data potentially provides event organizers with valuable information for managing the traffic around venues and adds invaluable tools for potential emergency situations
- **Emergency Management:** ability to direct and safely guide groups of people with information about

Figure 2: Potential movement analytics services [Source: INRIX /Machina Research 2016]



the congestion of movement in specific areas

- **Infrastructure Planning:** in planning new roads and infrastructures, measurements can be quickly obtained.
- **Out-of-Home (OOH) advertising:** measuring advertising impact and reach of messages is becoming a critical differentiator in the world of digital marketing.

The technology behind movement analytics will be shared later in this paper but imagination sets few limits, and eventually, any person, thing or device, connected through a mobile network will open new opportunities for services with movement analytics at their core. This will ultimately extend to any form of asset tracking or movement, for example of transporters, containers, animals and livestock, equipment, and wearables.

3 Challenges in movement analytics

Movement analytics requires the aggregation of information on the movement of thousands, if not millions, of different devices. Developing a successful approach to movement analytics is based on overcoming a number of technology challenges in using data generated by mobile networks. It is not just a matter of relying on GPS data from the mobile device as we shall see.

Movement analytics can be broadly divided into two categories:

population movement and vehicle movement. In many cases, the approach is the same but a few differences exist. Machina Research has identified four challenges in movement analytics as a whole:

1 Identifying suitable sources for data in mobile network infrastructures is crucial.

Extracting data directly from mobile devices for movement analytics would potentially impact services on mobile networks. Transferring this amount of data would be a significant and inefficient use of the network. Another option would be to extract the data from MSCs or GSNs, but here, the data is less accurate and more infrequent, providing less information. At the end of the day, the key thing is identifying the optimal place to extract this data with the greatest benefits and fewest costs. Through its many years of experience with location data and mobile networks, INRIX has determined that to identify the location of a mobile device, data is optimally aggregated from multiple Base Transceiver Stations (BTSs) with advanced analytics applied to the data. For vehicle movement, this information is complemented with GPS data as power is not an issue.

2 Determining a mobile device’s location between towers through signal strength has been a recognized approach.

This approach holds a number of challenges ranging from extremely low density tower coverage (single tower situations), to fundamental challenges of signal strengths being reflected off various surfaces and providing inaccurate readings. To achieve a successful identification of a mobile device location, the algorithms of the analytics tools will need to take all these variables into consideration as well as ‘recognize’ existing road and pathway infrastructures. Only by aggregating the various historical and real-time data sources is INRIX able to deliver accurate location information.

3 Mobile networks are optimized for voice and data transmission, not location identification.

Designed as such, close proximity to a tower may not necessarily determine a mobile device being connected to that tower for reasons of load optimization. Multipath routing may also mean that a connection of a mobile device is not where the device is located. One of the reasons why the INRIX solution combines a mobile device’s location based on cell tower data with GPS data is to deliver this greater location accuracy.

4 Using the mobile device alone won’t always work.

Global Positioning Systems (GPS) data from a mobile device provides an important source of location data, securing a high degree of location accuracy but in vehicle and

Figure 3: INRIX Movement Analytics Platform [Source: INRIX, 2016]



population movement, this GPS data combined with the volume of cellular network data is what delivers a rich and compelling service from INRIX.

In the case of vehicle movement, GPS data is enriched, if needed, with cellular network data. In the case of population movement, where the constant use of GPS may have the unfortunate impact of running down the mobile device's battery too quickly, here INRIX has designed the solution to optimize the data from cellular networks, and access, when and where possible, GPS data.

Where INRIX differentiates itself from, for example, other over-the-top solution providers for location based services, is by combining and intelligently analyzing cellular network data, GPS data and other sources of location information.

Movement analytics is about capturing the right data within the mobile network infrastructure with as limited intrusion as possible, and aggregating this network data with other sources of information such as GPS and historical data to build a robust and accurate representation of movement. Again, as outlined earlier, identifying the optimal place to extract data from in a mobile network remains a significant capability.

Intelligent combination of data and advanced analytics

The intelligent combination of the right historical and real-time data

from different sources and the application of different advanced algorithms such as control group testing, A/B testing and multi-variant testing is what delivers the strength in movement analytics.

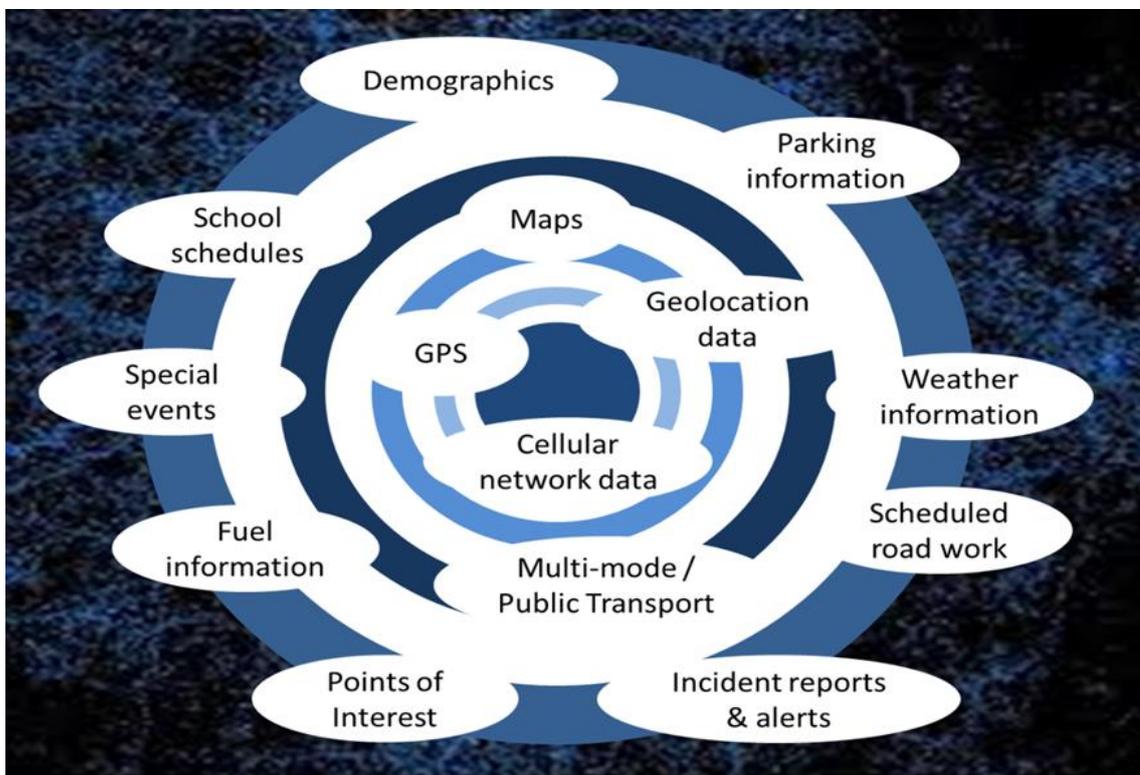
In the last two years, Big Data has made a definitive appearance on business agendas, with enterprises exploring opportunities to leverage larger data assets (data pools and lakes) and develop new products and services based on advanced data analytics. Core to this approach is the concept of data aggregation.

This aggregation is of data from multiple sources, providing different and valuable insights from each perspective. Isolated, the significance of the data may be important. Aggregated with other pieces of data, and applying tried and tested advanced algorithms is where the significance becomes potentially invaluable.

Figure 4 illustrates the range of data sources applied by companies like INRIX in providing movement analytics.

Core to all the data sources listed above is the data INRIX relies on from its network of over 300 million vehicles and smartphones worldwide to provide real time traffic and incident coverage on 5 million miles of road worldwide.

Figure 4: INRIX map of historical and real-time data sources [Source: INRIX, 2015]



4 Sensitivity around data privacy

Mobile operators are very well aware of the importance in managing data privacy and permissions in relation to such solutions as movement analytics. Combined with the knowledge and capabilities of an experienced partner such as INRIX, mobile operators will very clearly and confidently be able to share how their operations manages data privacy and permissions in a three-step process:

1 Implement aggregated and anonymized data processes

Step one involves ensuring that all data stored, managed and applied is aggregated and anonymized, achieving in the terms of the ICO, “...of turning data into a form which does not identify individuals and where identification is not likely to take place.”⁷

With over a decade of experience in aggregating and anonymizing data, INRIX is very well-placed to assist mobile operators with this ongoing responsibility, applying what has been termed best practice in the field of persistent key/value store for encryption processes.

⁷ Information Commissioner’s Office, definition of “anonymization.”

Where a number of anonymization processes are based on fixed keys for the data, INRIX applies a constantly changing persistent key scheme, ensuring best practice in anonymization processes.

② Proactive customer approach to privacy & permissions

Relying on technology to secure data privacy and permission delivers one side of the coin. In step two, mobile operator should extend their efforts to provide customers with the ability to opt-in or opt-out from such data schemes. In either case, customers should be made aware of the direct and indirect benefits which they could personally receive. For example in the case of an opt-in, customers could receive reduced tariffs or other incentives, and would also be contributing to solutions which may reduce carbon emissions.

Taking the proactive step to engage openly with the customer about data privacy and permissions moves this entire 'issue' a more transparent and potentially clearer win-win situation.

③ Building customer panels around data privacy and permissions

The third step relates to looking ahead. Mobile operators should actively seek to build customer panels to define, determine and design the data privacy and permission processes that should be part of the mobile operator's business.

In step three, customers are given the opportunity to help design and develop the best practices around data privacy and permissions in close collaboration with the mobile operator, and in return, secure suitable compensation for their effort and permissions.

The key to overcoming the barriers around data privacy and permissions for mobile operators will not be to wait for regulation to determine what is right or wrong but to actively engage with their customers, and build the best practices.

5 Monetizing movement analytics

There are two key elements for mobile operators to consider when monetizing movement analytics:

- Selecting the right partner
- Identifying the right business model

Selecting the right partner

The challenge for mobile operators will be to recognize that movement analytics is not an extension of their traditional data analytics or technology implementation capabilities but will require working with providers who have the tools, platforms and experience in aggregating data and applying, where circumstances require, more of a scientific mind to the approach than a technical one.

As with most substantial and complex data analytics processes, determining the 'noise' from important signals becomes crucial, and movement analytics is no exception to this rule.

Designing, testing and improving the appropriate algorithms to identify and remove this 'noise' remains one of the skills beyond the capabilities of mobile operators. Movement analytics is not just about capturing the data and presenting it. Movement analytics involves understanding how mobile networks work, involving such areas as signal strength, multi-path propagation, and umbrella cell approaches, all potentially creating 'noise' in the data. Mobile operators know a great deal about their networks but analyzing the data from the network requires partners with those skills.

And setting aside the technological capabilities, mobile operators should also look to partners such as INRIX who are accustomed to working with and selling into governments, city authorities, urban planners, transport systems, retailers and financial service companies. These are far from the standard engagement customers of mobile operators in anything apart from the narrowest of mobile contract portfolios; developing business relationships around movement analytics with these businesses will require collaborative approaches.

Identifying the right business model

Generating revenues from data assets remains achievable for mobile operators through two very different models:

- In the first business model, the mobile operator provides direct access to the network data to a data analytics partner such as INRIX. This partner aggregates the network data with other information sources, and sells movement analytics as a service to end customers. In this model, the mobile operator has the option of establishing a revenue share model with the data analytics partner, and secures part of the revenues
- In a second business model, the mobile operator could license the data analytics platform, and develop its own data analytics services for its customers, applying its own data, and selling the final movement analytics service directly to the end customer. In this model, the mobile operator receives the full revenue value of the service, and its main cost remains the license to the data analytics platform provider

Both approaches present advantages and disadvantages for mobile operators in terms of revenues, costs, time-to-market, skills, and effort to maintain. One important point for mobile operators to consider is that

developing a successful channel to market approach will not solely depend on having the technology but understanding the drivers, pain points and issues that retailers, city planners, financial advisers and advertisers can overcome with movement analytics.

The main point to be made is that within the businesses of mobile operators, historical and real-time data assets remain untapped revenue opportunities waiting to be monetized with the appropriate tools and partners. And once successfully delivered to one customer, the opportunity to transfer this service to other customers remains a significant opportunity for a mobile operator.

Movement analytics has started to impact applications in a wide range of sectors. In the previous White Paper, Machina Research identified, in Connected Cities alone in Europe, a EUR4.2 billion revenue opportunity in services⁸ by the end of 2020. Considering that movement analytics has started to impact such additional areas as digital signage, alternative traffic planning models, and real estate planning and valuations globally, this has significantly moved the scale of opportunities to what Machina Research has calculated to be EUR110 billion by the end of 2020 for applications which would

⁸ Service wrap equates to the value of services delivered via M2M connection, excluding the hardware and telecommunications costs associated with delivering it. For definition of service

contribute to and benefit from movement analytics.

Identifying 2.2% of this service wrap revenue opportunity as related to potential revenues from movement analytics in defined application groups delivers a revenue opportunity for MNOs in the region of EUR2.5 billion by the end of 2020.⁹

6 The INRIX story

Founded in 2004, INRIX is one of the fastest growing Big Data companies in the world. Core to the approach of the INRIX Traffic Intelligence Platform is the continuous and real-time analysis of data from multiple sources including a crowd-sourced network of more than 175 million real-time vehicles and devices.

From traffic management to movement analytics

With its acquisition of ITIS in 2011, INRIX enhanced its capabilities in traffic prediction and firmly consolidated its global position as the service provider of live traffic information. Based on over a decade of transforming cellular data into traffic information, INRIX has started to extend the application of its Big Data approach and techniques to deliver population and movement analytics.

wrap see the “Guide to M2M Forecast Database” document.

⁹ 2.2% is what has been achieved within connected cities in earlier models.

Managing more than 1.5 billion data points on any day, INRIX has started to build comprehensive insights around movement analytics, combining both real-time data sources with historical information and patterns to visualize and predict movement with increasing levels of accuracy.

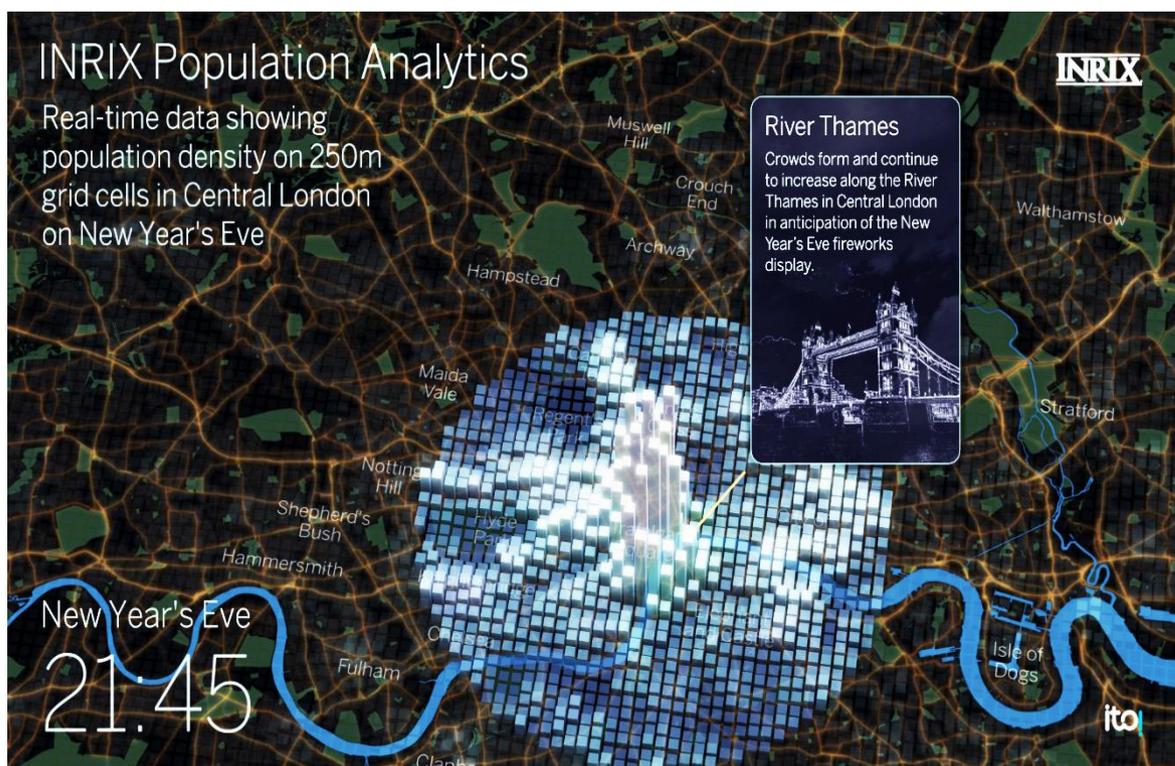
Extending services through partnerships

INRIX as a company has recognized that this market space will require partnerships, and in 2014 has launched a number of important and ground-breaking partnerships to

further develop its services. These partnerships include:

- **Intel** – working together with INRIX on Smart Cities platforms and applications, all powered by Big Data. In early trials, Intel and INRIX have designed applications “to help the city of San Jose monitor air quality levels citywide more cost-effectively, better manage population growth as well as reduce traffic congestion during major events.”
- **Samsung** – working together with INRIX to deliver traffic-powered mobile applications for the connected car. This partnership includes such apps as “Morning!”

Figure 5: Visualisation of New Year's Eve movement analytics [Source: INRIX/ITO World, 2016]



Smart Alarm Clock App and the integration of INRIX XD Traffic app with the Samsung Gear S Smartwatch.

- **Porsche Automobil Holding SE** – made a strategic investment in INRIX to address the growing connectivity between cars and infrastructures.

INRIX is already at the forefront of enabling real-time traffic and driver services for automakers like Audi, BMW, Ford, Mercedes, Volkswagen and Toyota. In the public sector, more than 60 transportation agencies worldwide use INRIX traffic information and analytics tools to streamline daily operations, pinpoint investments in roads and transit as well as deliver better traveler information services.”

Movement analytics is not science fiction

Partnering with a leading mobile operator in the UK, INRIX delivers Big Data and movement analytics as a new and compelling service on the market. By analysing the footfall around specific locations, and identifying where customers may have originated, decision-makers in retail, property, transport, media and leisure are able to tap into crucial information about both the location and the customers, improving insights around customer flows and marketing segments.

All data analysed is aggregated and anonymised mobile network data.

The mobile operator and INRIX have gone to great lengths to remove any individual ‘signatures’ or profiles that could put customer privacy at risk, and as evidenced by the results, this is aggregated information, not individual behaviour.

The power of data analytics combined with mobile network data will be further enhanced in particular settings such as Smart Cities. Supporting traffic management and public transport systems in operation, the results of movement analytics may be applied at various stages.

In terms of planning, the results of movement analytics may guide city planning, retail planning location permissions, and planning of new transport routes. These will address such topics as urban and smart mobility which ultimately may include smart parking, smart ticketing, bicycle-sharing schemes, car sharing and taxi booking services. Additional benefits of movement analytics may be identified from the rapid provisioning of emergency escape routes based on analysed data, or the immediate rerouting of traffic around major venues and events, or perhaps most interestingly, being able to capture and analyse in real-time the movement of groups based on individuals decisions and actions (how people evacuate an area) and where best to have assistance resources ready.

Recent INRIX use cases

In the following and all use cases delivered by INRIX and their local mobile operator partners, experience and best practice around data privacy and permissions have been closely monitored and applied.

These use cases illustrate the strengths, capabilities and flexibility of movement analytics, each returning substantial benefits to the city, the citizens and customers in general.

INRIX Movement Analytics Global Use Cases

Colorado Department of Transportation

- *The Colorado Department of Transportation (CDOT) has chosen INRIX for mobility intelligence to analyze transportation data to promote state-wide safety and infrastructure improvement. CDOT deployed INRIX Real-time Traffic Flow and INRIX Insights Performance Measures to analyze data, create a benchmark for measuring the impact of various highway initiatives across Colorado, and compare the performance of Colorado's state-wide transportation systems. Through state-wide access to analytics and visualizations, CDOT is enabling cross-agency coordination to unite and enhance the effectiveness of planning efforts throughout Colorado.*
- *"Colorado has an 11,000 foot mountain pass of Interstate with urban-like traffic congestion. Measuring reliability, delays, mobility, safety and infrastructure conditions for this region is a tricky business," said Ryan Rice, CDOT's director of the division of transportation systems management and operations. "INRIX's technology helps us maximize our dollars, be more surgical with our strategy and decipher what is or isn't working. The analytics will also help to pair with other data systems to deliver real-time information to travellers."*
- *According to Rice, INRIX Insights plays a clear role in uncovering what is happening, when it's happening and where it's happening. The platform also helps demonstrate the magnitude and immediate impact of transportation decisions and initiatives*

Congestion Relief Scheme Study

- *The use of mobile data also has important applications for local and highway authorities, who are already using it to plan road network changes and measure travel time with great precision. Examples of INRIX's work in this area include a travel time measurement system used by Connect Plus to manage one of the busiest motorways in Europe, the M25 London Orbital; providing essential data for the M25 Junction 30 Congestion Relief Scheme Study undertaken by Jacobs UK Ltd on behalf of the UK Highways Agency; and a venture in partnership with Mouchel and Transport for Greater Manchester to build a multi-modal picture of travel across a wide area.*
- *Many other examples exist: INRIX's Incidents platform, for example, which provides detailed information and insight around major disruptive incidents*

	<p><i>(public transport strikes resulting in more traffic on roads, for instance). Monitoring such incidents is clearly vital to public sector organisations, but to date understanding such data using conventional qualitative methods has been difficult; population analytics makes it highly accessible.</i></p>
<p>Manchester Trafford Centre Study</p>	<ul style="list-style-type: none"> • <i>The use of movement analytics to analyse trips and population densities during such events as shopping events provides invaluable insights for retailers in terms of future marketing plans and ensuring a pleasant and well-organised customer experience.</i> • <i>In the Manchester Trafford Centre Study, a larger Lock-in shopping event was organised for students, and studying the trips and traffic patterns of groups of people visiting the Centre, retailers could identify such patterns as modes of transport used, peak and trough shopping times, and the origin and routes of shoppers. The latter information - routes - provided an invaluable source of information for the future placement of billboards and advertising in the lead up to future events.</i>
<p>New Year's Eve in Central London – Trafalgar Square</p>	<ul style="list-style-type: none"> • <i>Major events such as New Year's Eve celebrations at Trafalgar Square in London, UK (or any major city in the world) brings together masses of people for that one celebratory moment every year, lasting no more than a few hours but significantly requiring exceptional transport and route planning and management tools for city planners and events' organizers.</i> • <i>Applying the INRIX movement analytics tools, events' organizers and emergency services, being able to follow the flows of movement, can identify points of (potential) congestion, how transport is coping with the movement of peoples and again, for future planning, provides invaluable information about the points of origin and routes taken by people so that suitable information can be placed at the appropriate places on the way into the City centres.</i>

7 Conclusions & recommendations

To remain competitive, mobile operators will continuously look to identify and build new revenue streams. Based on existing mobile network assets, movement analytics presents itself as a growing and untapped revenue opportunity for mobile operators. Transforming data into a clear service proposition such as movement analytics for customers will require a better understanding of what the benefits are, how to achieve this data transformation, and who to partner with.

To tap into this new market opportunity, Machina Research recommends executives of mobile operators to:

- **Identify the benefits and opportunities from Big Data and advanced data analytics.** Moving the benefits and opportunities in Big Data and data analytics from internal business intelligence projects to internal/external focused opportunities will require a clear and strategic framework in place for operators, and will certainly need to balance the exploitation of these data assets without compromising data privacy and data ownership.
- **Appoint the right team within the business to lead this initiative.** For many mobile operators, technical infrastructures remain the core

of the business. When dealing with data analytics, having the knowledge about data processes will be important but more so will be the commitment and enthusiasm to build new revenue streams from existing assets.

- **Leverage experience from business intelligence but understand that aggregating multiple data sets is a completely different challenge.** Operators may think that doing more of the same within analytics will allow them to launch such new and innovative services but nothing could be further from the truth. Aggregating data, and ensuring that data is processed in the most appropriate fashion is not a one-off capability but a continuously learning process, and only with this experience will costly mistakes be avoided
- **Choose the right partners with the right skills.** Big Data and advanced data analytics will deliver significant technical challenges. In terms of scale, speed and structure, the aggregation of data will reach new heights and require new technologies. And in terms of transforming raw data into data of value, mobile operators should look to partner with service providers with the right skills and experience.

8 About INRIX

INRIX is one of the fastest growing big data technology companies in the world. Through cutting-edge data intelligence and predictive technologies, INRIX helps leading automakers, fleets, governments and news organizations make it easier for drivers to navigate their world.

Our vision is simple – to solve traffic, empower drivers, inform planning and enhance commerce. Whether through an in-car or smartphone navigation application, a local newscast or our mobile apps, our up-to-the-minute traffic information and other driver services help millions of drivers save time, fuel and frustration.

INRIX delivers traffic and driving-related insight, as well as sophisticated analytical tools and services to over 400 customers, on five million miles (8 million km) of road in 45 countries. Acquired by INRIX in 2015, ParkMe has built the world’s most comprehensive parking database that includes more than 29 million spaces in over 90,000 locations spanning 4,000 cities in 64 countries.

For more information visit us at www.INRIX.com.

Figure 6: Real-time traffic data management [Source: INRIX, 2016]



9 About Machina Research

Machina Research is the world’s leading provider of market intelligence and strategic insight on the rapidly emerging Machine-to-Machine (M2M), Internet of Things and Big Data opportunities. We provide market intelligence and strategic insight to help our clients maximise opportunities from these rapidly emerging markets. If your company is a mobile network operator, device vendor, infrastructure vendor, service provider or potential end user in the M2M, IoT, or Big Data space, we can help. We work in two ways:

- Our **Advisory Service** consists of a set of Research Streams covering all aspects of M2M and IoT. Subscriptions to these multi-client

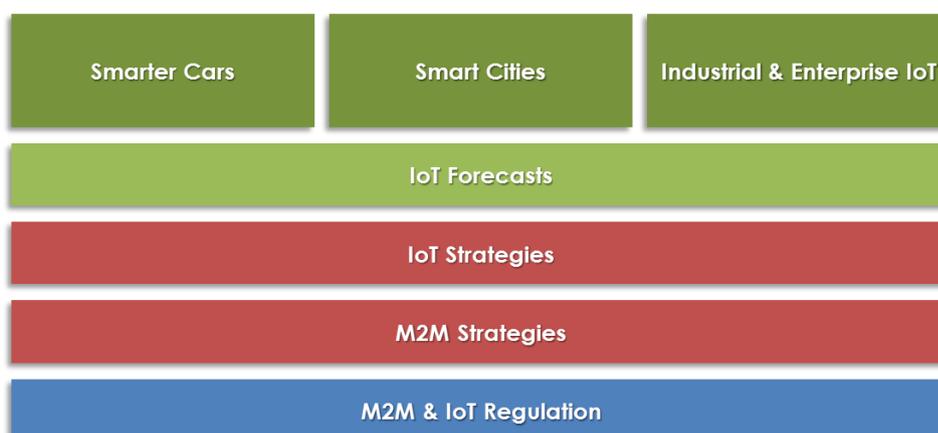
services comprise Reports, Research Notes, Forecasts, Strategy Briefings and Analyst Enquiry.

- Our **Custom Research and Consulting** team is available to meet your specific research requirements. This might include business case analysis, go-to-market strategies, sales support or marketing/white papers.

Machina Research’s Advisory Service provides comprehensive support for any organisation interested in the Internet of Things (IoT) or Machine-to-Machine (M2M) market opportunity. The Advisory Service consists of a number of Research Streams (as illustrated in the graphic below), each focused on a different aspect of IoT or M2M. They each provide a mixture of quantitative and qualitative research targeted at that

The Machina Research Advisory Service Comprises 7 Research Streams

- M2M Strategies and IoT Strategies pull together our horizontal expertise, supported by M2M & IoT Regulation
- Forecasts and application analysis for our five ‘Connected’ verticals (Cars, Cities, Health, Industry and Living & Working) consolidated in the IoT Forecast Research Stream
- Smarter Cars, Smart Cities and Industrial & Enterprise IoT Research Streams delve deep into addressing the requirements, opportunities and challenges of car manufacturers, city managers and enterprises as they deploy IoT



specific sector and supported by leading industry analysts.

Machina Research's analysts also have a wealth of experience in client-specific consultancy and custom research. Typical work for clients may involve custom market sizing, competitor benchmarking, advice on market entry strategy, sales support, marketing/promotional activity, and white papers.

For more information, refer to our website at <https://machinaresearch.com>, or email us at enquiries@machinaresearch.com.